Gusset Design and Analysis of the RIA Two Spoke Cavity

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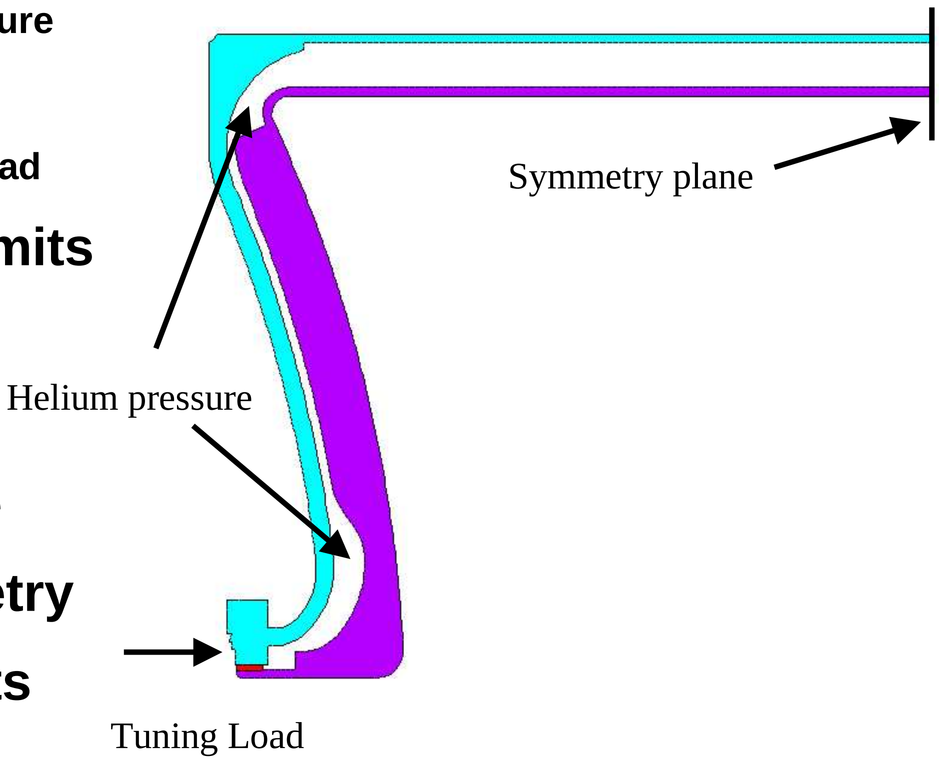
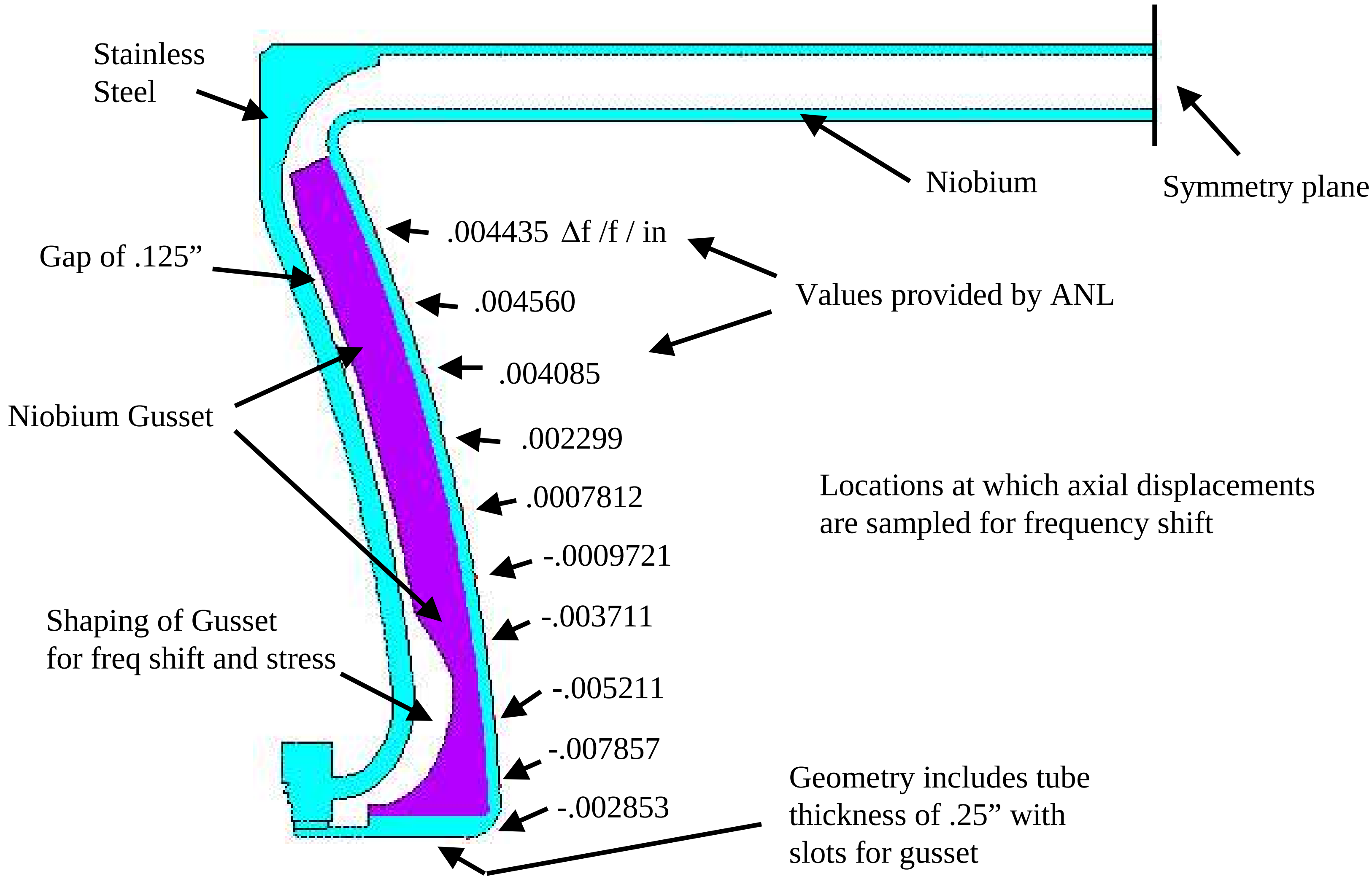
Purpose

- **Gusset was shaped to minimize pressure induced frequency shift (K. Shepard)**
  - **Effects of system pressure**
    - **tolerance of helium bath pressure**
      - **18 psi ± 3 psi**
  - **Effects of mechanical tuner**
    - **frequency shift from a given load**
- **Room temperature stress limits**
  - **Helium pressure load**
  - **Tuning load**
  - **combined**
- **Minimize the helium volume**
- **2- D to define gusset geometry**
- **3- D to determine 3- D effects**



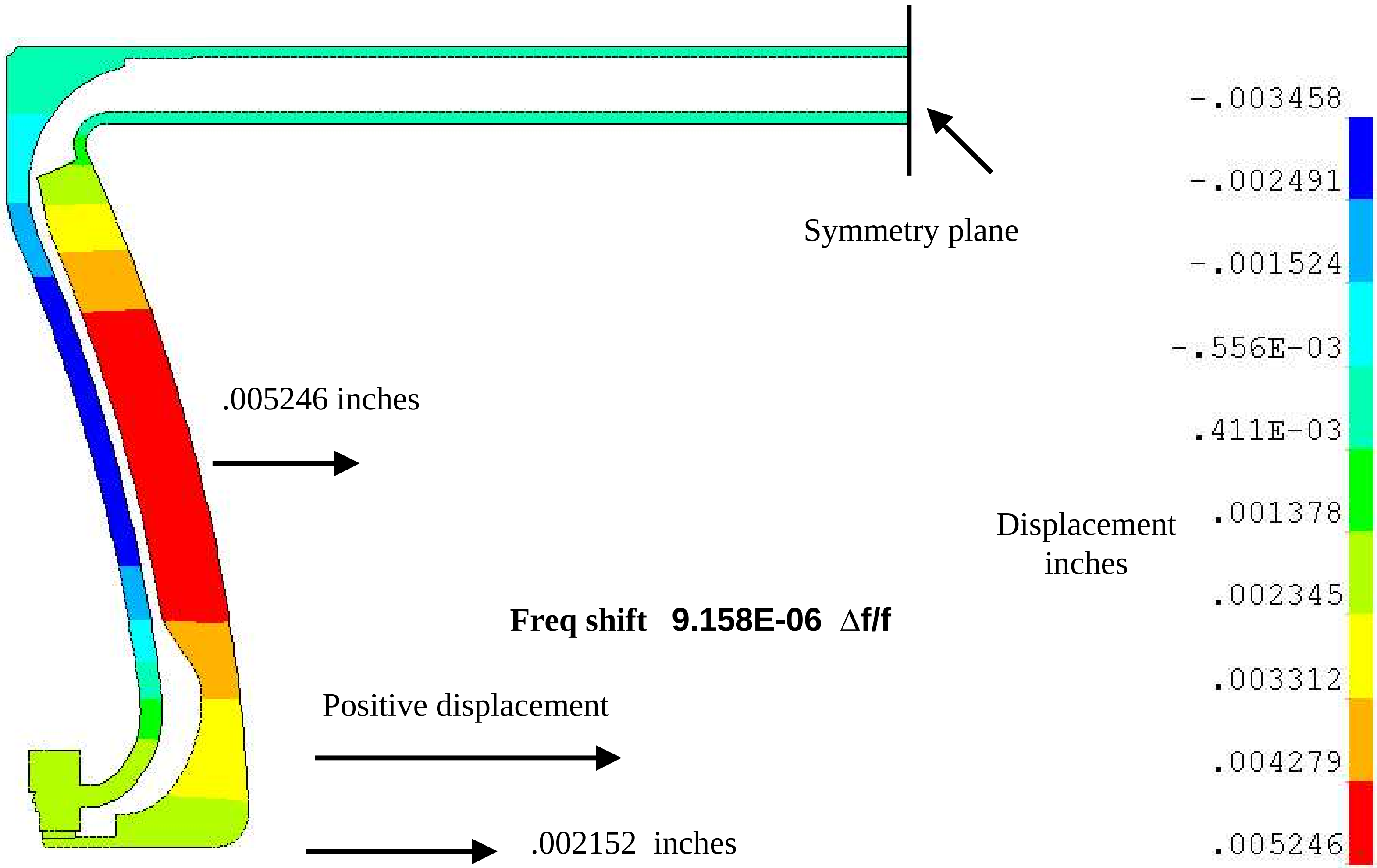
Gusset geometry and frequency shift sensitivity

- **Final Gusset geometry after many trials**



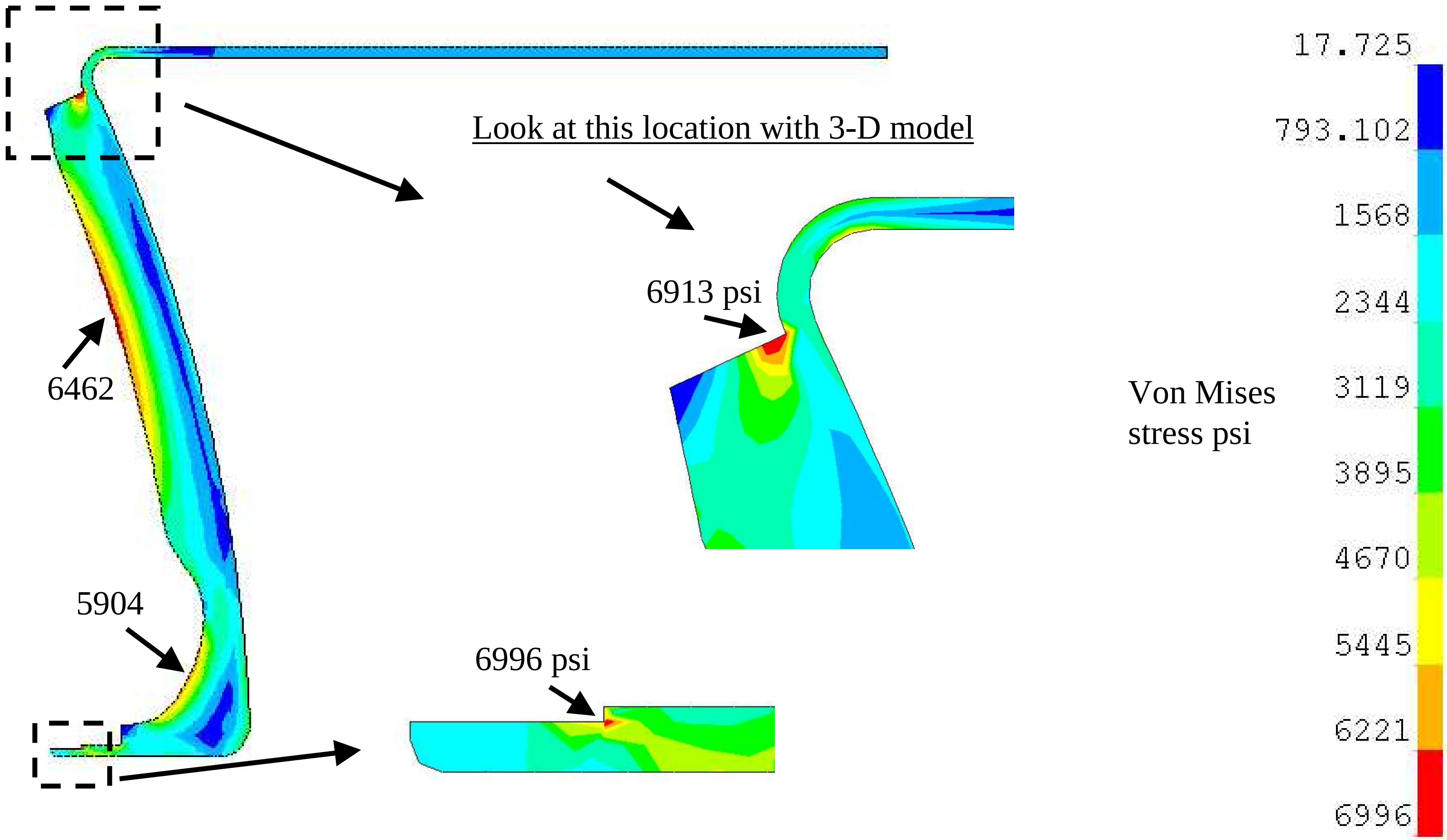
Displacements due to pressure load

21 psi pressure load

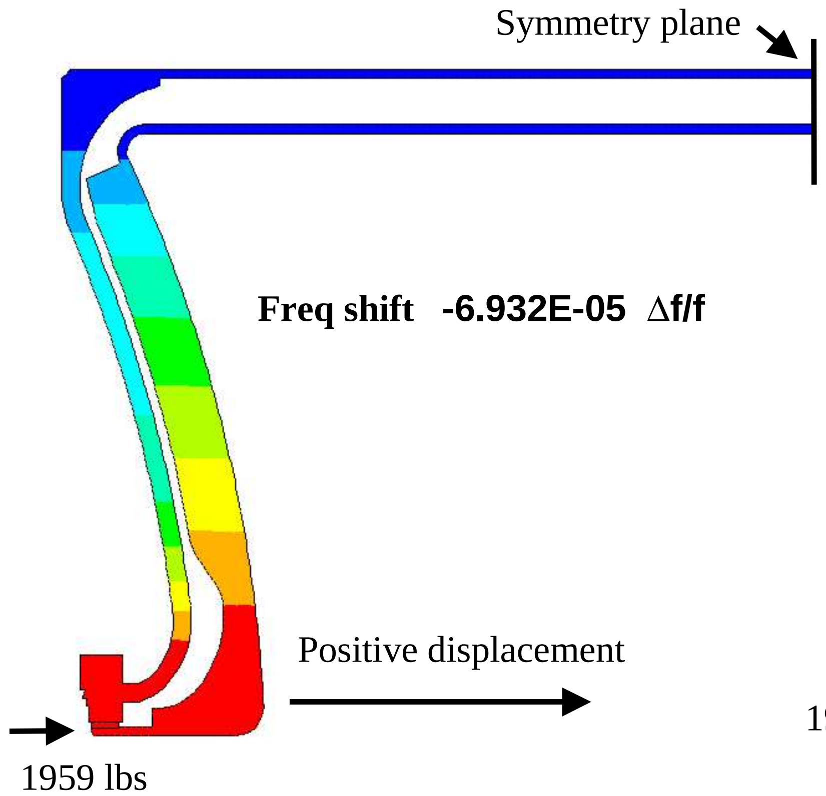


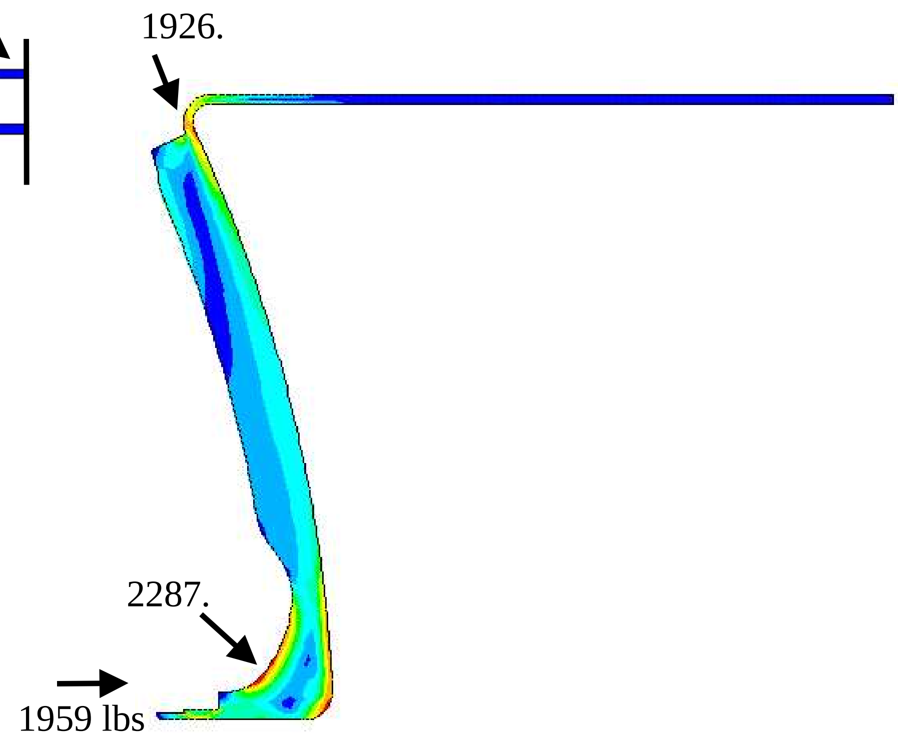
von Mises stress from pressure load

- **21 psi helium pressure**



Tuner force load results





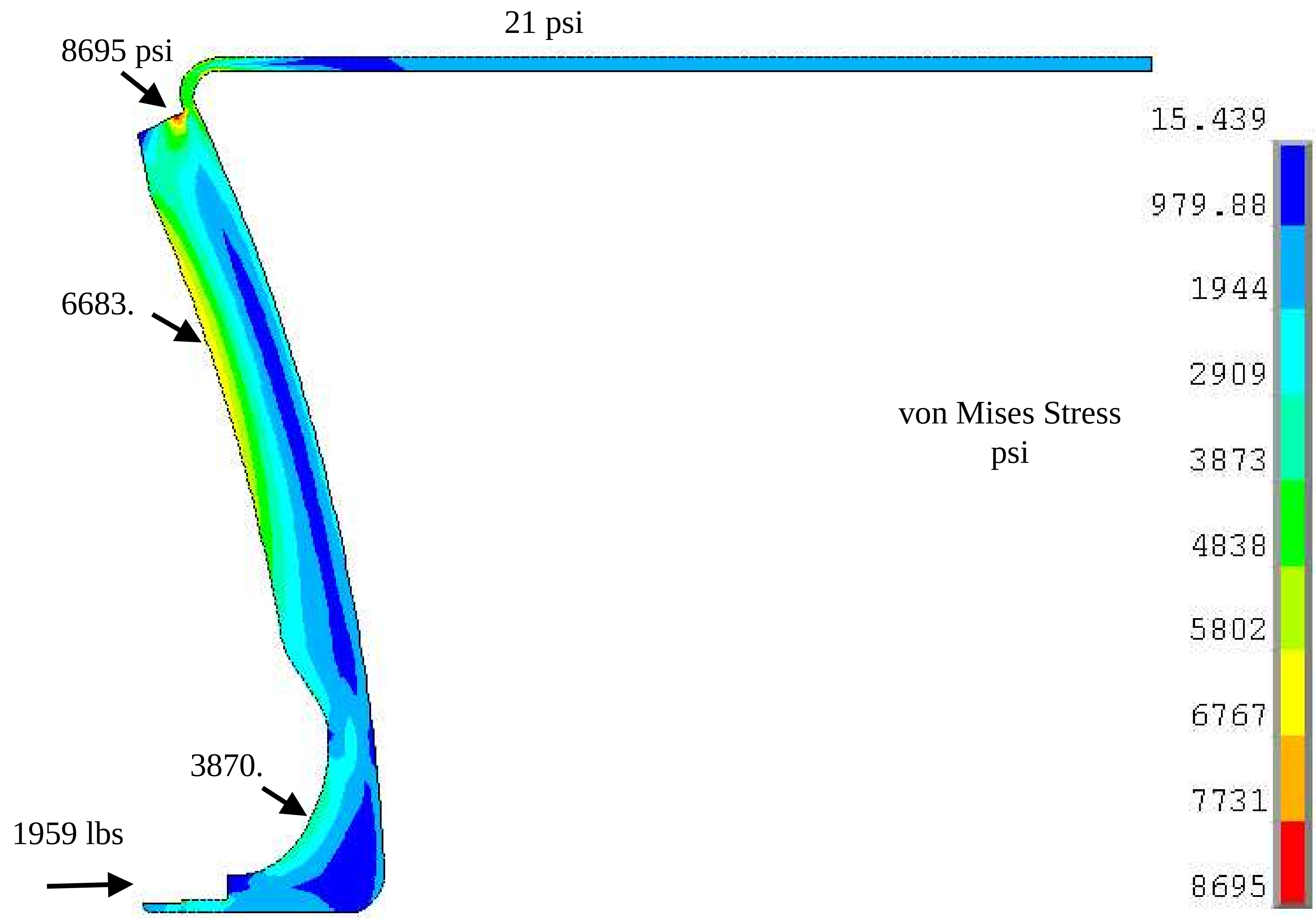
Displacement inches

.607e-3 .001857 .003107 .004358 .005608
-.187e-4 .001232 .002482 .003733 .004983

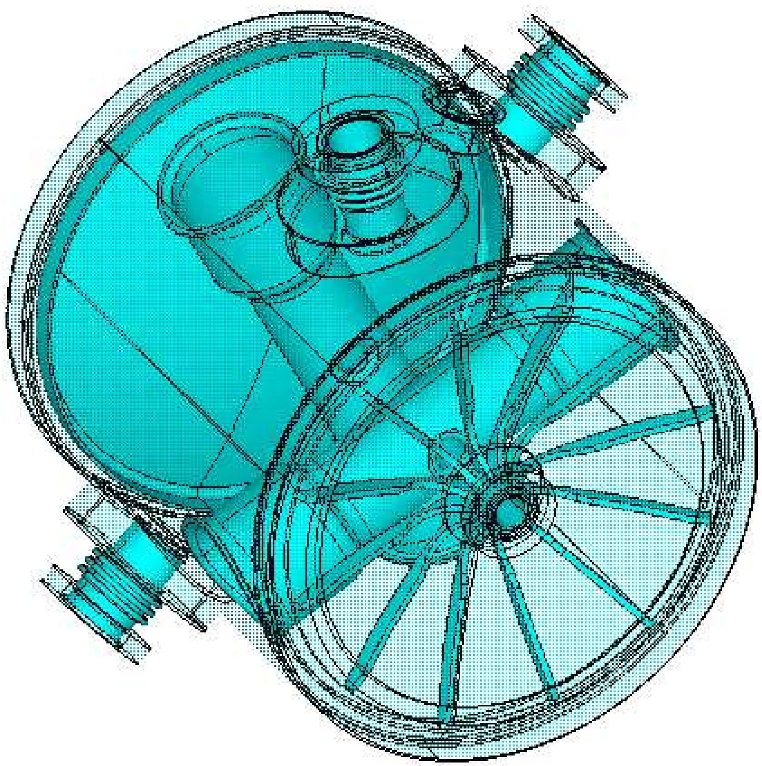
von Mises stress psi

258.0 769.7 1281. 1793. 2305.
2.21 513.9 1026 1537. 2049.

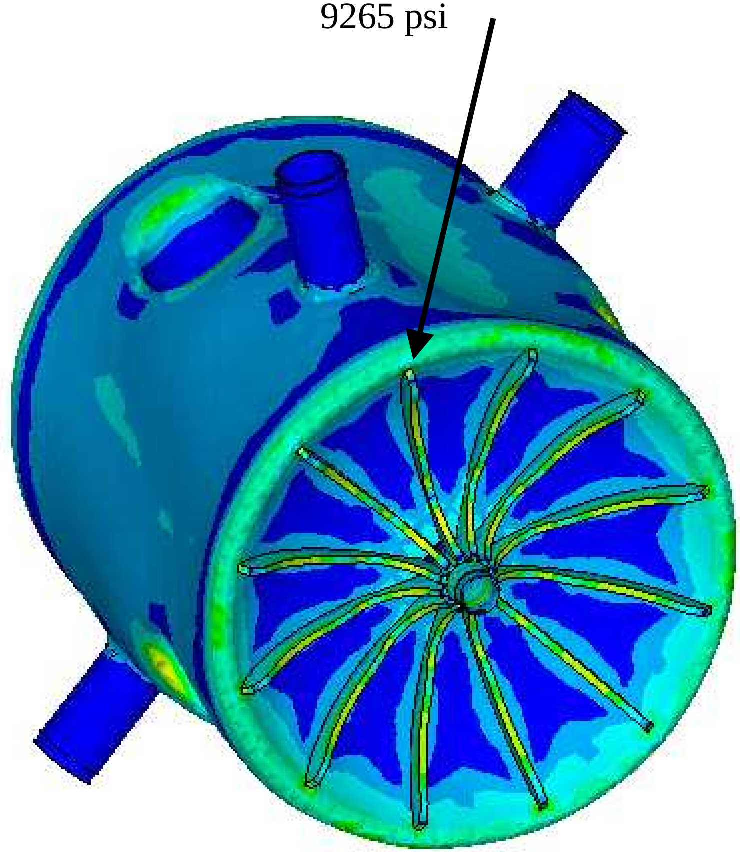
von Mises stress pressure + tuner loads



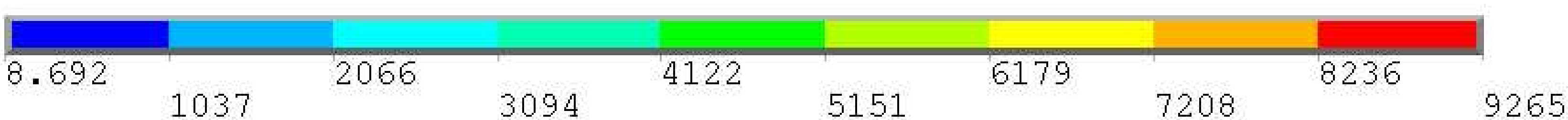
3-D model RT pressure stress results in niobium



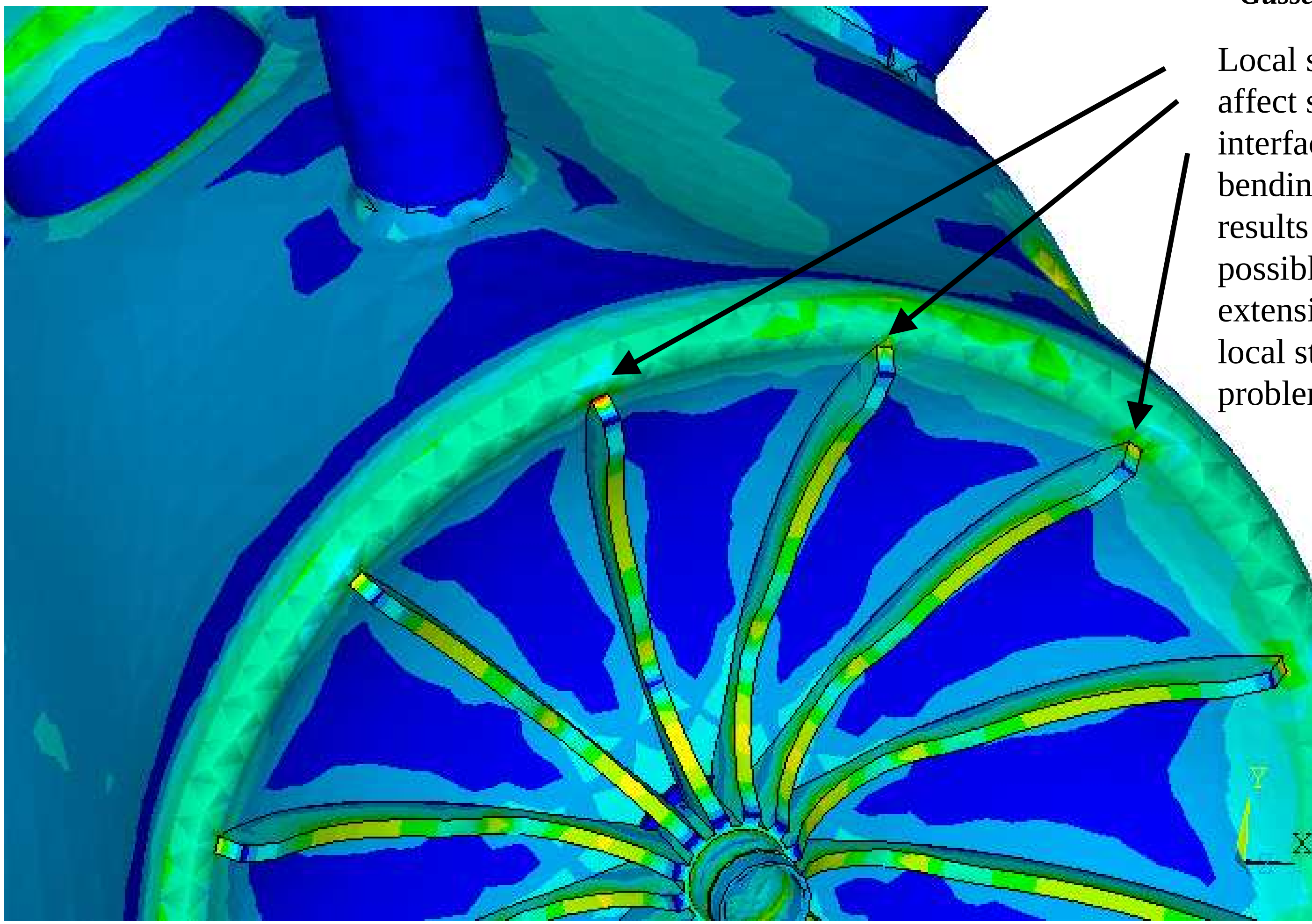
Highest stress in model occurs here
9265 psi



Von Mises Stress In Niobium PSI

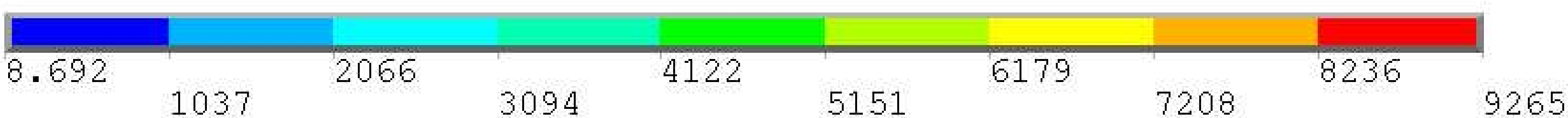


RT pressure stress results in niobium



Local stiffness changes affect stress at gusset interface, very local bending stress, similar results on other side, if possible could move extensions back, however, local stress may not be a problem

von Mises Stress
psi



Tensile yield properties of niobium*^

Material	Room Temperature ksi	77 K ksi	4 K ksi
Niobium RRR 250	9.7	89.6	95.4
Niobium RRR 250 weld	10.2	64.5	68.2
Niobium RRR 40 (reactor grade)	11.0	64.2	67.9**
Niobium RRR 40 (reactor grade) weld	13.9	65.3**	47.4**

* From R. P. Walsh, et. al., "Low Temperature Tensile and Fracture Toughness Properties of SCRF Cavity Structural Materials", 9th Workshop on RF Superconductivity, paper tup014, Santa Fe, New Mexico, 1999.

^ Values are for 0.2% yield unless otherwise noted by **

** Failure occurs before 0.2% offset is reached

Conclusions

- **We have designed a Gusset stiffener to mitigate pressure induced RF frequency shifts**
- **Room temperature stresses are higher than we would have liked but are local and are not expected to result in an adverse effect on the overall structure**
- **Strength of Niobium significantly higher at 77K and below**
- **Using 12 1/4 inch thick flat gussets**
  - Frequency shift
    - **Pressure shift** **9.158E-06 $\Delta f/f$**
    - **Tuner shift** **-6.932E-05 $\Delta f/f$**
    - **Tuner/pressure shift ratio** **7.57 times**